TRAILS:

Soil and Water Resource Considerations

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Forest Service Role

in water and watershed stewardship

- Improves, protects, and enhances watershed health
- Provides strategies for solving complex environmental problems
- As a district Hydrologist my job involves trying to understand and mitigate impacts to soil and water resources.

Bottom Line:
Assess how every proposed action could potentially impact soil and water resources.

EXAMPLE ONE:

EVALUATING LIVESTOCK GRAZING

SOIL CONDITION ASSESSMENTS

Wickiup April 2010

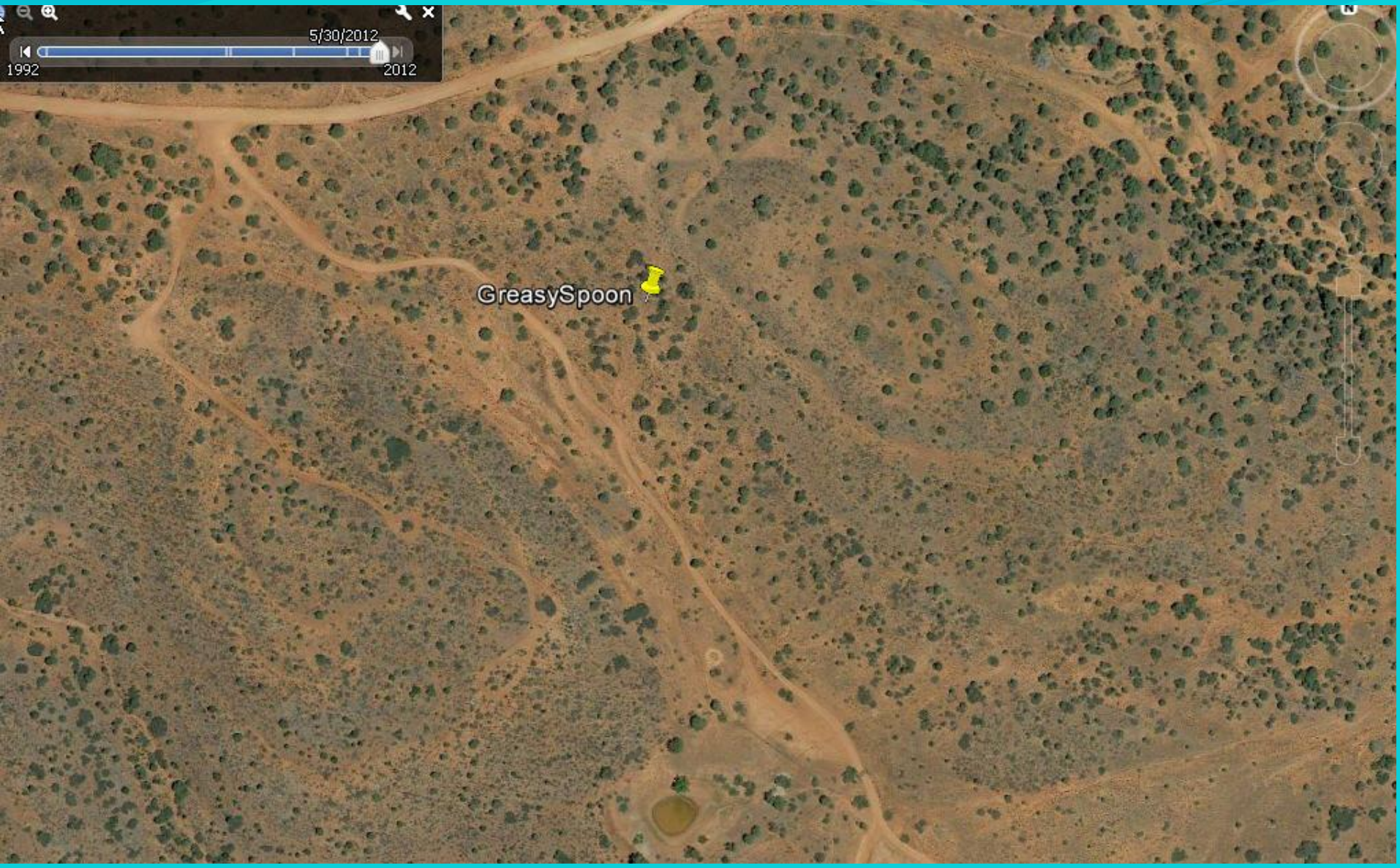
Note:

- Piping above headcut
- Lack of litter and vegetative ground cover

Wickiup November 2012

EXAMPLE TWO:

EVALUATING JEEP TOUR ACTIVITIES



Relocation of a road to improve long-term drainage and lower maintenance costs.


RED ROCK TRAIL ADDITIONS
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Forest Service uses the "Terrestrial Ecosystem" mapping to determine landscape features of concern. The entire forest has been evaluated and mapped for these features.

TES Map Unit	Phase	Slope	Erosion Hazard	Condition Rating	Trail Limitation Rating	Comments	K Value
045	Deep, cobbly loamy fine sand	0 - 5	Slight	Satisfactory	slight	Low water holding capacity and subject to flooding.	0.20
402	Mod to deep, very cobbly silty clay loam	0 - 15	moderate, mass wasting hazard	unsatisfactory	severe, low strength	Low revegetation potential due to the high dominance of clays.	0.10

(Example of TES information)

Why do we need well planned trails in Red Rock Country?

- So many people, so much use – need to minimize effects
- Consolidate trail use onto suitable areas,
- Protect watershed health
- allows for trails to be properly maintained.

Erosion: So What?

It is not possible to completely prevent all erosion, but erosion can be reduced to tolerable rates.

Definition of tolerable soil loss:

The maximum rate of soil erosion that will permit indefinite maintenance of soil productivity, i.e., erosion less than or equal to the rate of soil development.

Revised Universal Soil Loss Equation (RUSLE)

$$A = R * K * LS * C * P$$

where

A = estimated average annual soil loss (tons/acre/year)

R = rainfall/runoff factor, quantifying the effect of raindrop impact and the amount and rate of runoff associated with the rain, based on long term rainfall record

K = soil erodibility factor based on the combined effects of soil properties influencing erosion rates

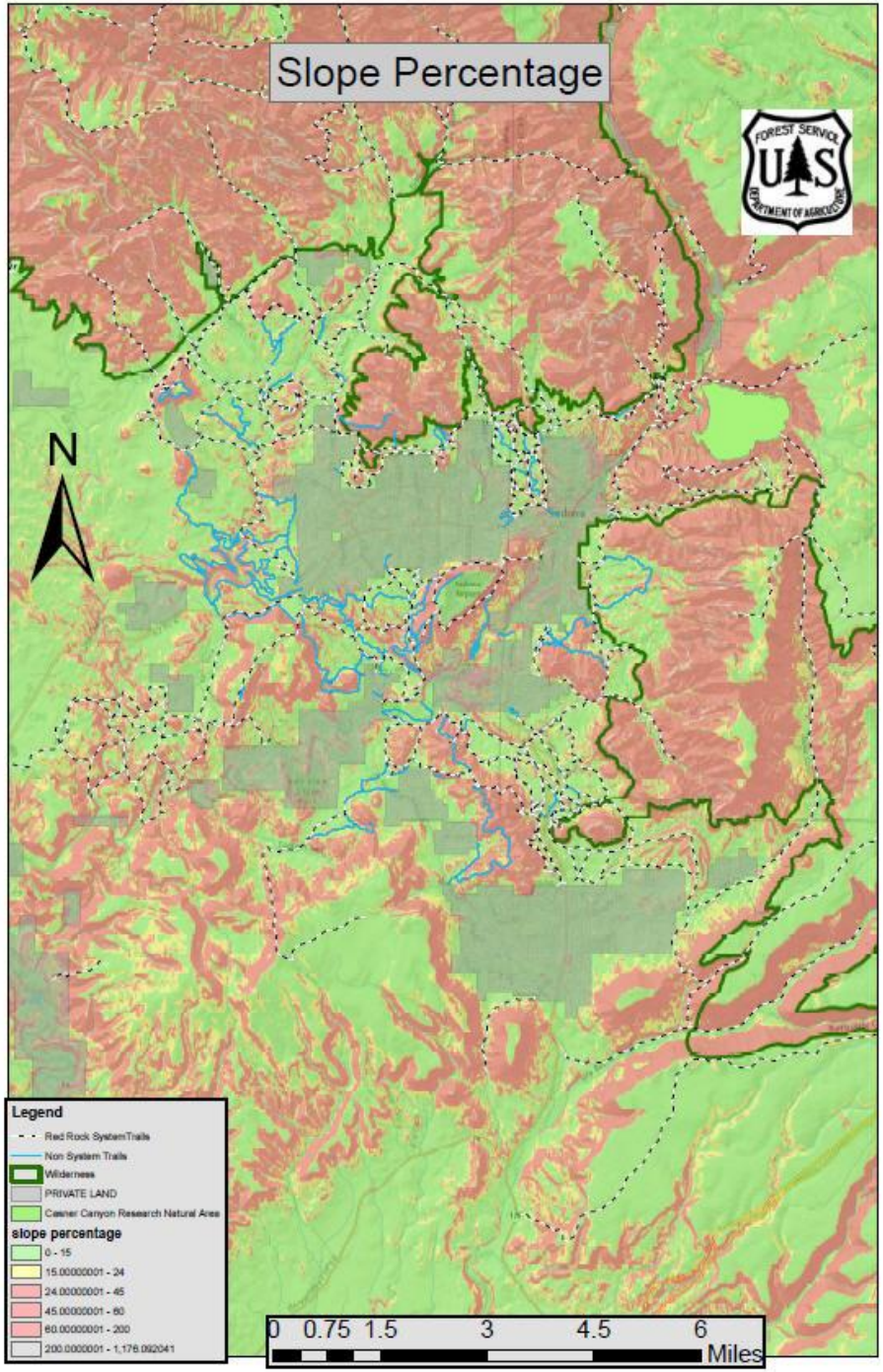
LS = slope length factor, a combination of slope gradient and continuous extent

C = cover and management factor, incorporating influences of crop sequence, residue management, and tillage

P = practice factor, incorporating influences of conservation practices such as contouring or terraces

Red Rock Country has extensive areas with slopes in excess of 25%.

These areas need special attention if they are to be developed for sustainable trails.



Design criteria can include:

Placing trail on the contour,

Avoiding trails that run down the "fall line",

Armoring steep segments with rock,

Avoiding any trail on steep slopes,

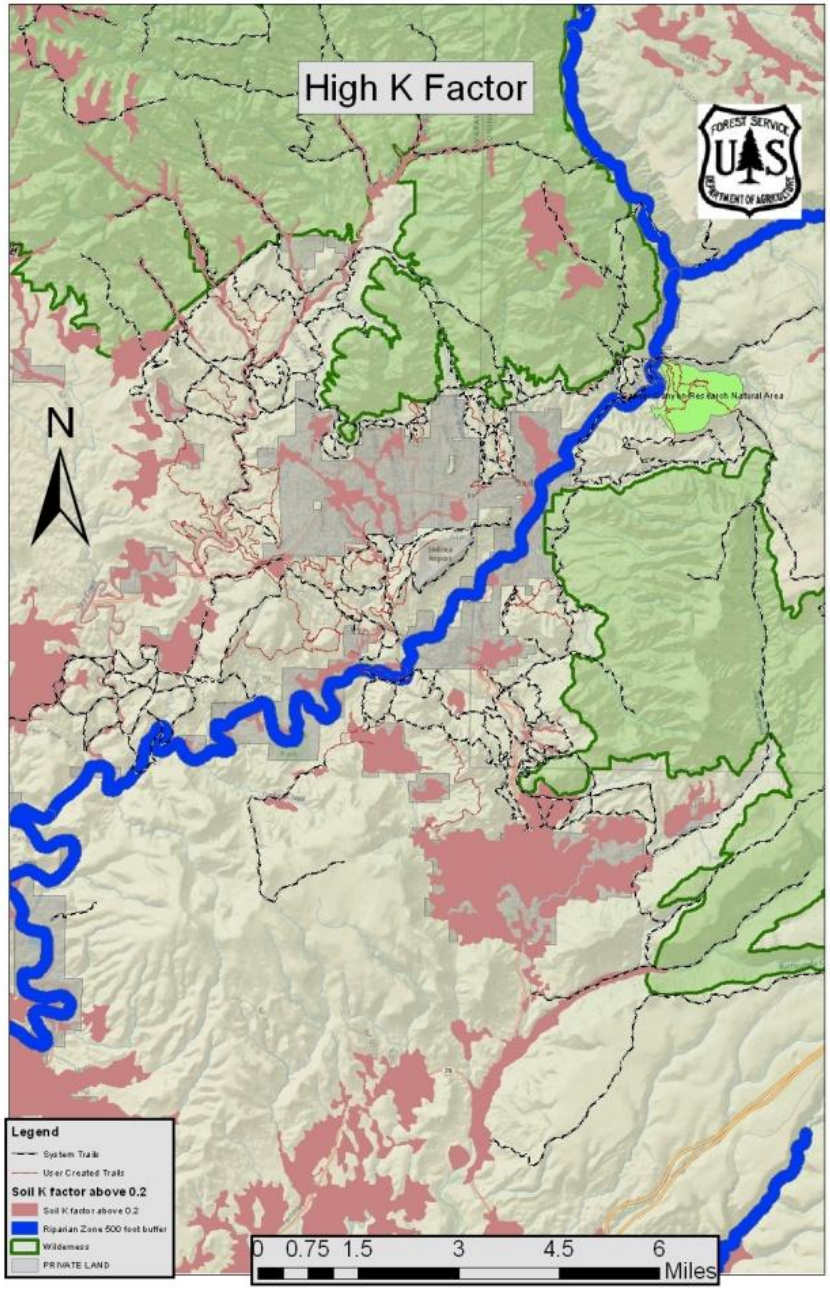
Ensuring proper drainage!

Factor K

Factor K indicates the susceptibility of a soil to sheet and rill erosion by water.

Soils having the highest K factor are the most erodible.

Red Rock Country has some extensive areas of high K factor…highly erosive soils.



Soil Hazard Rating Definitions:

Slight

Rates do not exceed tolerable soil loss (TSL) rates (rate at which soil is annually renewed). Loss in soil production potential and risk of sediment delivery down slope is of low probability.

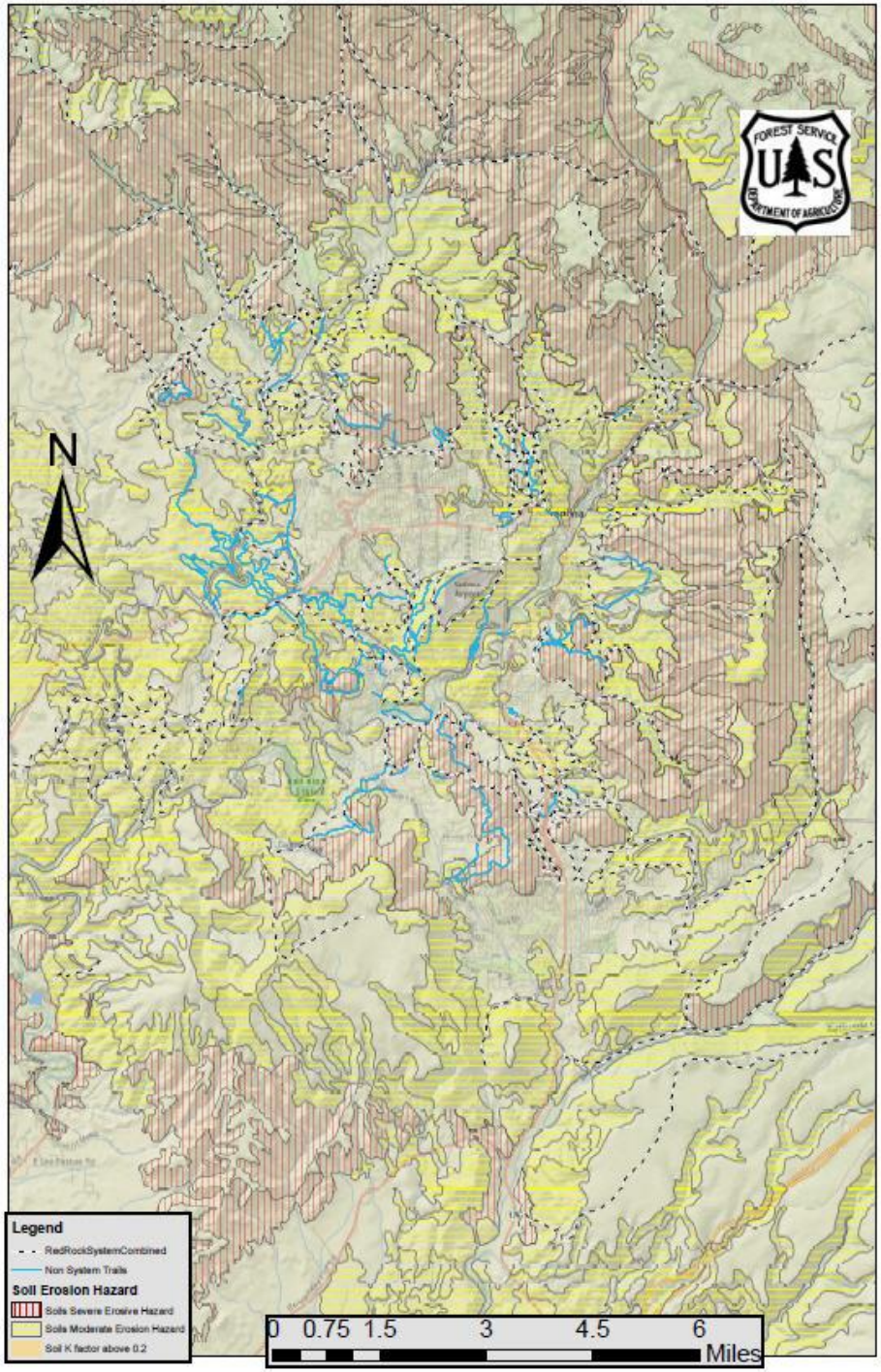
Moderate

Rates exceed TSL rates (rate at which soil is annually renewed). Loss in soil production potential is probable and significant if unchecked. There is risk of sediment delivery down slope. Mitigation measures are reasonable and economically feasible.

Severe

Rates exceed (TSL) rates (rate at which soil is annually renewed). Loss in soil production potential is inevitable and irreversible if unchecked. There is a high probability of lowering site productivity.

Most areas around Sedona and VOC have moderate to severe soil hazard ratings.



Sustainable trails can be built in these areas if they are carefully located and designed.

What is Desert pavement?

“Desert pavement” is the rocky rubble that sits on the surface of the ground and protects the soil from blowing or washing away.

What makes Sedona Soils Unique?

High K factor

High amount of Biological Soil Crust

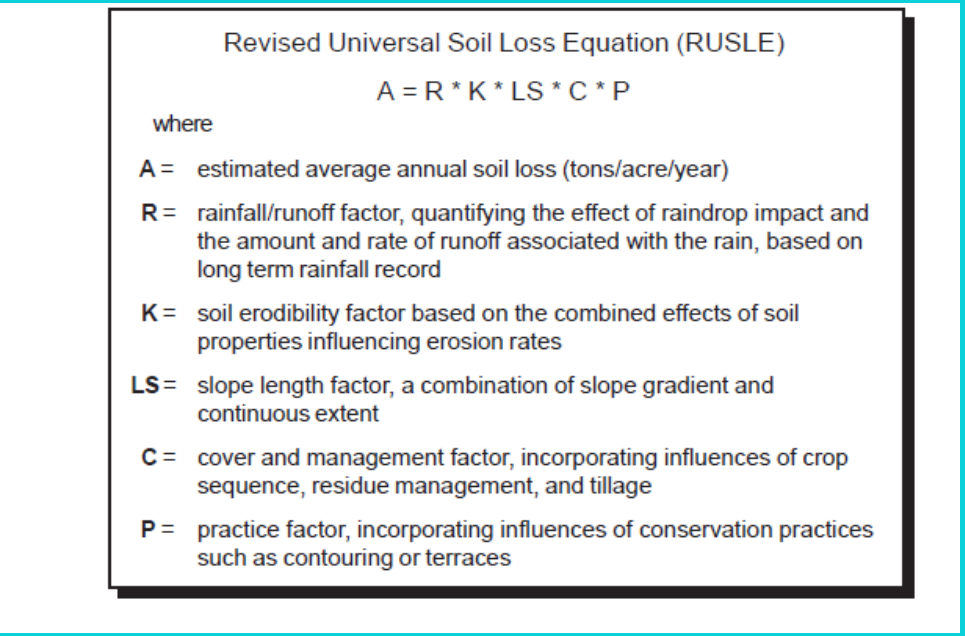
High rainfall Intensity

Low vegetative Cover

Steep Slopes

High Use

Fragile Desert pavement



Why do we care?

Sustainable Use = Sustainable budget = Long term trail additions

We are on a very erosive landscape

Sediment flows downstream into our precious Oak Creek

Trail density is approaching a maximum, how much is enough?

What's the big deal with one trail?

The cumulative effect of all the trails must be considered.

Recreation and Water Quality

- Unplanned trails are not designed correctly
- Creating social trails without looking at the big picture
- Poorly located trails can denude stream banks of vegetation
- Causing sedimentation

Pollution

Point source

Pollution

Nonpoint source

WATER QUALITY REGULATIONS that the USFS must abide by:

- Section 319 of the Clean Water Act specific to nonpoint source pollution control
- Executive Order No 11988 Floodplain management
- PL 92-500 Federal Water Pollution Control Act
- Arizona Department of Water Quality Standards

WATER QUALITY REGULATIONS

- EPA cited SEDIMENT as the leading cause of impairment in rivers.

- Oak Creek is an Outstanding Arizona Water and has strict water quality anti-degradation standards tied to sedimentation.

Water Quality Parameters of Concern

Sedimentation

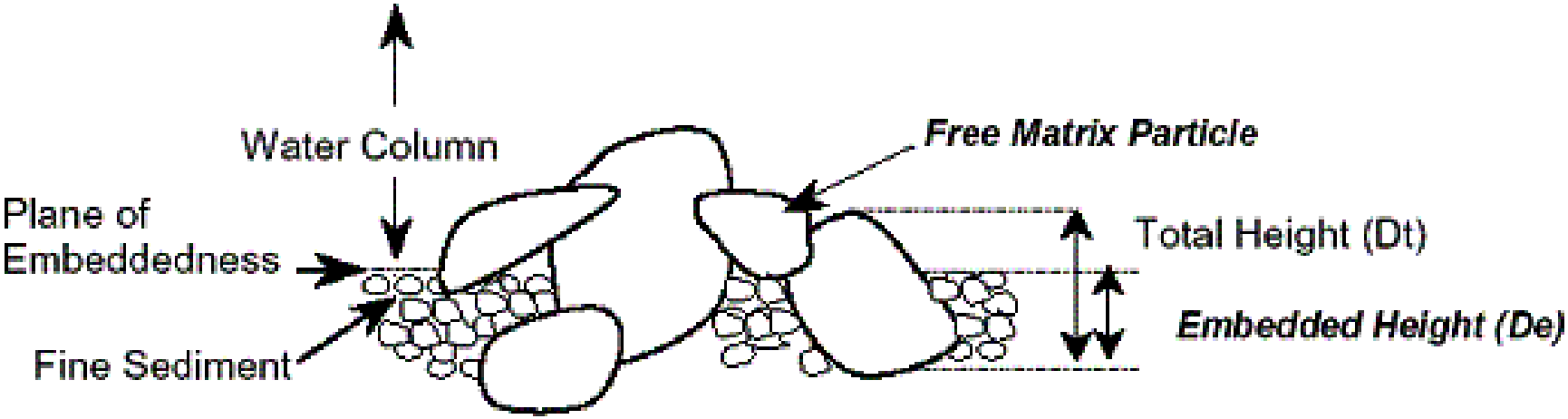
- Turbidity
- Total Suspended Solids
- Total Dissolved Solids
- Embeddedness

Nutrients

Temperature

Escherichia coli

Sediment from trails can smother the life in Oak Creek!




Riffle embeddedness ~50%

Aquatic Invertebrates

Species Sensitive to Sedimentation and Embeddedness:

- Mayfly nymph

- Stonefly nymph

- Caddisfly Larvae

How do we mitigate trail impacts?

The 11 Essential Elements of Sustainable Trails

These 11 principles are essential to creating the rolling contour trails that can help control erosion and keep visitors on the trail where they belong. These principles work together as a system. When applied collectively, they create sustainable trails that are low maintenance, fun to use, and that help manage risk, environmental impact, and user conflict.

These principles can be summarized as one goal: Get water off the trail and keep users on it.

How To Do It

An ideal trail will simultaneously incorporate these sustainable trail principles:

1. **Trail location:** Sidehill trails are best
2. **Sustainable trail alignment:** Avoid the fall line
3. **Half Rule:** Guides trail alignment
4. **Sustainable grade:** Follow the ten percent average guideline
5. **Maximum sustainable grade**
6. **Grade reversals:** Unbeatable drainage
7. **Outslope:** Ensuring sheet flow
8. **Adapt trail design to soil texture**
9. **Minimize user-caused soil displacement**
10. **Prevent user-created trails**
11. **Maintenance**

> The goal of sustainable trailbuilding is to get water off the trail and keep users on it.

1 Trail Location: Sidehill Trails Are Best

First by designing a sustainable trail from the beginning.

BEST MANAGEMENT PRACTICES (BMP)

Rec-4. Motorized and Nonmotorized Trails

Manual or Handbook Reference	FSM 2353, FSH 2309.18, FSM 7715.5, FSM 7723, and EM (Engineering Management) 7720-104.
Objective	Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources by controlling soil erosion, erosion of trail surface materials, and water quality problems originating from construction, maintenance, and use of motorized and nonmotorized trails.

USFS manages trails using BMP's

Examples of BMP for trail

Rock armoring of steep sections to prevent erosion.

Examples of BMPs, cont…

Minimizing stream crossings by trails.

Elevating stream crossings

Reducing cross country travel.

Closing and rehabilitating user-created trails

Avoid Biological Soil Crust

Example of trails located poorly to start with – Impossible to maintain…..

Steep trail crossing a wash – too steep and erosive.

Trail alignment down the "fall line" too steep to drain properly – impossible to maintain.


BIOLOGICAL SOIL CRUSTS

And it's called what?!

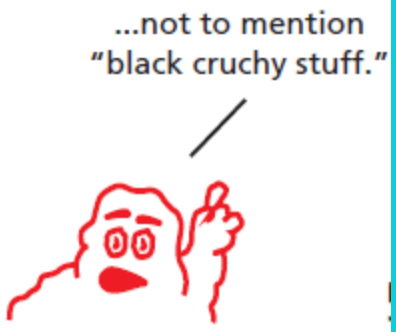
Biological... (because it's made up of living things)

Soil..... (because it's in the soil)

Crust..... (because it forms a crust on the soil)

Biological Soil Crust!

You might also hear it called
cryptobiotic soil crust,
cryptogamic soil crust,
or microbiotic soil crust...



Crusts generally cover all soil spaces not occupied by vascular plants, and may be 70% or more of the living cover

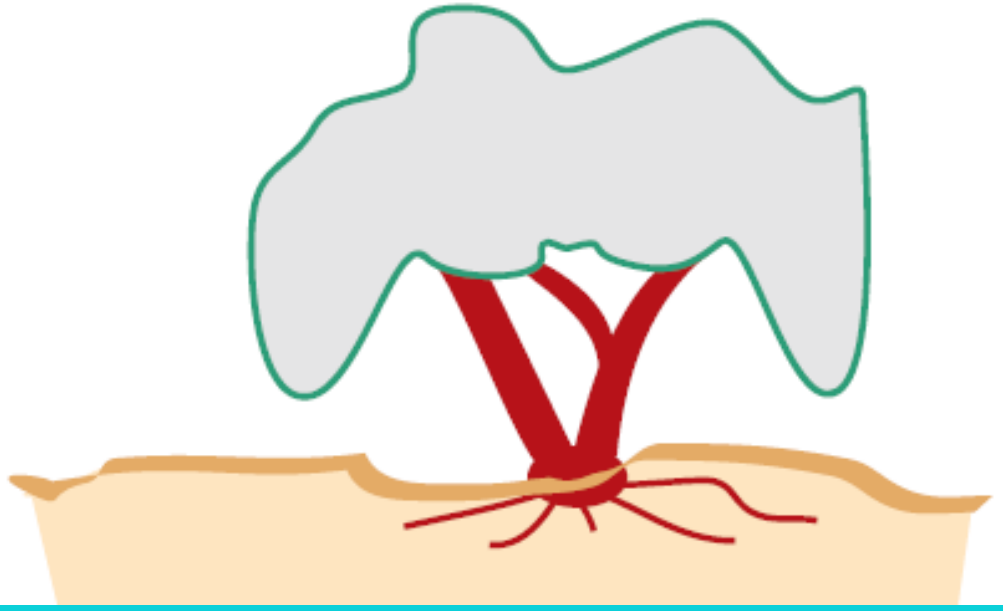
We need to be careful when we are out with the crust.

If it gets crushed by feet or tires it dies and can't hold the soil together.

Please be careful where you walk!

And when the biological soil crust dies, that means:

1) No more holding the soil in place;
2) No more nitrogen added to the soil;
3) No more bumps to catch water and seeds;
4) Less food for plants.



As you can imagine, the plants are not very happy about any of this...

Table 27.2. Estimated recovery times of dated disturbances of known severity in the Mojave, Sonoran, Chihuahuan and Colorado Plateau deserts of the western US (J. Belnap et al., unpubl.)

Desert type	Disturbance severity	Soil texture	Annual rainfall range (mm)	Elevation range (m)	Years since disturbance	Estimated recovery times (years)				No. of lichen species	
						Cyanobacteria	*Collema*	Other lichens	Moss	Disturbed	Control
Coastal	Removed	Fine	179	100	5		>20–200	>200		1	5
Cool	Removed	Coarse	220–230	1500–1800	10–14	14–34	50–400	>200–875	82–>766	1	4–5
		Fine	230	1600	14	9	>20–240	>200	>140	1	3–5
	Crushed	Coarse	220–230	1500–1800	6–13	7-14	10–71		26–39	1	1–4
		Fine	215	1550	2	2	6	3	4	1	2
Hot	Removed	Coarse	119–230	271–1730	50–80	<81–100	217–1250	580–3700	<81	2	2–7
	Crushed	Coarse	74–248	500–950	2–20	3	10–90	>9		1	1–2
		Fine	248–256	500–1300	2	2–3	4–15	>4		1	2

Area with no “desert pavement” or “soil crust”. Soils vulnerable to wind and water erosion.


Without protection our “sugary” soils blow or wash away.
Where do the sediments go? Into Oak Creek!

Good Management is the art of making problems so interesting and their solutions so constructive that everyone wants to get to work and deal with them---- Paul Hawken (1987)

Armoring work on the Huckaby Trail.

The Forest Service Mission is to :
"Sustain the health, diversity, and productivity of the Nation's Forests and grasslands to meet the needs of the present and future generations"